

Extra Credit 1

CMSY-199, Spring 2013

50 points

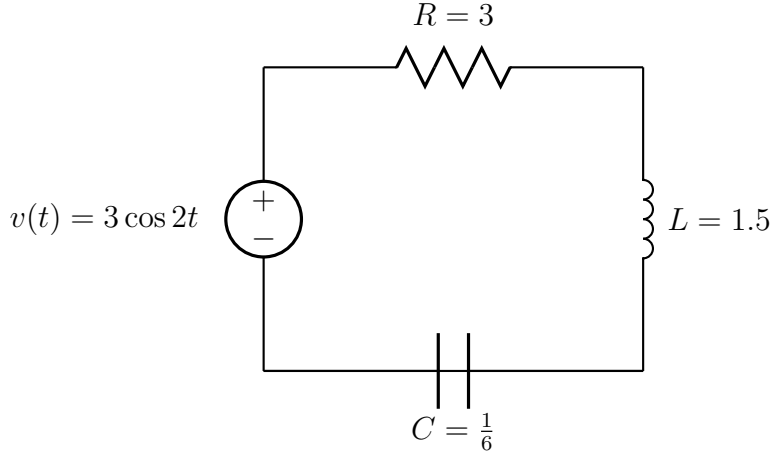
The source code for this assignment must be submitted electronically using the Canvas course website prior to the start of class on Monday, April 15.

A common application of complex numbers in the field of Electrical Engineering involves converting a real-valued AC Circuit into a complex-valued Phasor Circuit. The Phasor Circuit *greatly* simplifies the solution of the AC Circuit although it does require the manipulation of complex numbers rather than real numbers.

1. Write a class called `PhasorCircuit` which *has* two member variables:
 - (a) a double named `frequency`
 - (b) a three-element array of type `Complex` named `impedance`
2. Write a constructor that takes four doubles named `w`, `R`, `L`, and `C`. Assign the argument `w` to the member variable `frequency`. Use the formulas shown in the Phasor Circuit for \mathbf{Z}_R , \mathbf{Z}_L , and \mathbf{Z}_C to initialize the `Complex` member variables `impedance[0]`, `impedance[1]`, and `impedance[2]` from the arguments.
3. Write a method called `solveCurrent` which takes an argument of type `Complex` named `phasorVoltage` and returns a `Complex` type. Use equation (2) below to compute and return the phasor current, \mathbf{X} .
4. Make the `PhasorCircuit` class a Java application by adding a `main` method to:
 - (a) Create an instance of type `PhasorCircuit` called `seriesCircuit` using the parameters ω , R , L , and C shown in the AC Circuit below. *Hint*: be careful not to perform integer division when computing C .
 - (b) Create an instance of type `Complex` called `phasorVoltage` with the value of the phasor voltage, \mathbf{V} , in the Phasor Circuit below.
 - (c) Print the phasor current by calling the `solveCurrent` method of the `seriesCircuit` object with `phasorVoltage` as the argument.

AC Circuit

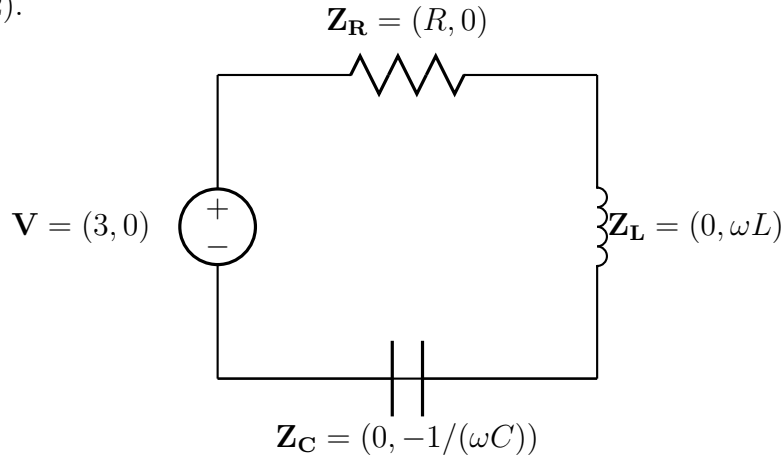
An AC Circuit with an ideal voltage source of $v(t) = 3 \cos 2t$ volts is connected in series to three circuit elements - one $R = 3$ ohm resistor, one $L = 1.5$ henry inductor, and one $C = \frac{1}{6}$ farad capacitor. Note that the frequency of the voltage source is $\omega = 2$ radians/s. The resulting current, $x(t)$ amperes, is given by the differential equation (1).



$$\frac{d^2x(t)}{dt^2} + \frac{R}{L} \frac{dx(t)}{dt} + \frac{1}{LC} x(t) = \frac{1}{L} \frac{dv(t)}{dt} \quad (1)$$

Phasor Circuit

The corresponding Phasor Circuit has phasor voltage $\mathbf{V} = (3, 0)$, resistor impedance $\mathbf{Z}_R = (R, 0)$ ohms, inductor impedance $\mathbf{Z}_L = (0, \omega L)$ ohms, and capacitor impedance $\mathbf{Z}_C = (0, -1/(\omega C))$ ohms. The resulting phasor current, \mathbf{X} amperes, is given by the algebraic equation(2).



$$\mathbf{X} = \frac{\mathbf{V}}{\mathbf{Z}_R + \mathbf{Z}_L + \mathbf{Z}_C} \quad (2)$$

After solving for the phasor current, the current in the original AC circuit is given by equation (3).

$$x(t) = \text{Re}[\mathbf{X} \cdot (\cos 2t, \sin 2t)] \quad (3)$$